An Assessment of the Regional R&D Effort in India: An Inter-State Analysis of Some Selected Industrially Advanced States

Dr. Vikram Chadha

One of the prime determinants of the growth of the regions in a country is the development of technological base and technological services in the productive sectors in that region. Technological development of various economic activities in a region not only catalyses the growth of productivity and efficiency of production structures, but also draws new skills; know-how; ingenious expertise and capabilities, and the in-migration of dexterous S&T manpower into those regions, which in turn provides an enormous impetus and builds potential for a relentless growth of the particular and related productive activities. Spill-over from new technological development has further cascading effect on the surging economic activity, owing to which the region explodes with economic vibrancy and dynamism manifesting in the phenomenal expansion of income, output and employment in the region (Hoover, 1975).

As the technological development activity advances in different regions/states, the regions tend to specialize, resulting in a discernible reduction in costs and the reinforcement of the comparative and competitive advantage in the area of regional specialization (Richardson, 1996). This is most particularly relevant to the contemporary phase of global development of economies. Such regional specialization due to research and development effort backed by local resource endowments and production requirements would induce the comprehensive development of the region.

The Indian economic policy, since the very inception of the planning era in the country, has hinged on the balanced development of regions. But, nonetheless, the in-built dynamism for growth of some regions has eventuated in perceptible imbalanced regional economic development of the country. Some states, which due to their natural or historical advantages, launched on vigourous industrialization programmes, have far exceeded other regions/states as far as industrial development is concerned. For instance, Punjab and Haryana, which till recently were growing at the fastest rate among the Indian states, riding on the crest of an agricultural boom since the mid 1960s, have yielded top slot to some industrially developed states like Maharashtra and Gujarat[1]. Certainly, technological advances and industrial R&D in the industrially advanced states in the country has accentuated growth of these regions.

The present paper is an attempt to analyse the growth and pattern of industrial R&D in the seven selected industrially advanced[2] states in India, including West Bengal; Maharashtra; Gujarat; Karnataka; Tamil Nadu; Andhra Pradesh and Uttar Pradesh, since the beginning of the economic reforms process during early 1990s in India.

Results And Discussion:

(i) Extent of R&D Expenditure in the State Sector:

In the federal polity of the country, the constituent states are also required to carry out their own R&D programmes in the different productive sectors in order to fulfill the

regional and local technological aspirations and requirements according to the primacy of respective productive sectors. Thus, along with the national R&D expenditure and institutions at the central level, the states have their own set up. Table 1 depicts the R&D expenditure in the state sector, and portrays a dismal picture, that relative to the national effort, the R&D expenditure in the state sector has remained in the range of 7-10 percent of the aggregate national R&D expenditure during 1990-2001, which is too paltry. During this period, where the national R&D expenditure grew at a yearly rate of about 15 percent, the R&D expenditure in the state sector progressed at about 13 percent per annum.

(ii) State-wise R&D Expenditure in the Selected States:

Table 2 depicts that out of the state sector R&D expenditure during 1990-99, Maharashtra accounted for the largest proportion ranging between 12-15 percent, and its R&D expenditure grew from Rs.53.7 crore to over Rs.129 crore during this period at an annual rate of over 10 percent. This is followed by Gujarat where the R&D expenditure hovered between 11-14 percent except in 1994 when its proportion fell to 3.4 percent of the total R&D expenditure in the state sector in India. Currently Gujarat is spending the highest amount on R&D for technological development of its industry, i.e. over Rs.147 crore, growing at 14.4 percent per year. Uttar Pradesh has also been spending about 9-13 percent of the total state sector R&D expenditure, growing at about 8 percent per annum. Though Karnataka has many large industrial units, both in the public and the private sectors, yet its relative expenditure on R&D is lower, though the annual growth rate of R&D expenditure is the highest at 15 percent. The only state where R&D effort seems to have nosedived is Tamil Nadu, where its share in R&D expenditure in the state sector in India has plummeted from a high of 7-8 percent, to only 2 percent in 1999, which is quite disconcerting. Thus there is a wide variation among states as far as R&D spending for technological development of the states is concerned, which is in congruity with the results of an earlier study (Chadha, 1998).

(iii) Patents Applied For: The Output of the Regional R&D Effort:

Table 3 configures data on R&D output, manifesting in patent applications filed in the selected states during 1990-99. The table highlights that the most industrially developed state Maharashtra excelled all others as far as the number of patent applications filed is concerned, showing a substantial industrial research activity in the state. During 1990 to 1999, the number of patent applications rose from 183 to 695 in Maharashtra. Though Tamil Nadu registered a declining rate of growth of R&D expenditure as shown in table 2, but from the patent statistics the R&D activity in the state apparently seems reasonably satisfactory. West Bengal also came up with 196 patent applications during the period of 1990s.

(iv) Industrial R&D Expenditure in the Public and Private Sector Industries in the Selected States:

Table 4 purports that the growth of industrial R&D expenditure has been the fastest in Gujarat with an annual rate of growth of over 20 percent during the 1990s such that the state's industrial R&D expenditure leapfrogged from Rs.14.9 crore in 1990, to over Rs.208 crore in 1999. Similarly in the most industrially advanced state of Maharashtra, it

grew by over 18 percent per annum, from Rs.18 crore to Rs.1200 crore during 1990-99. The growth of industrial R&D has been the slowest at 4-5 percent per year in Andhra Pradesh and West Bengal mainly on account of the declining public sector R&D in these states, registering a negative growth of public R&D spending. Whereas in the industrially developed state of Andhra Pradesh, Karnataka and Uttar Pradesh, the public R&D spending predominated largely due to the presence of large public sector industrial units in these states, but on the other hand in other industrial states like Gujarat, Maharashtra, Tamil Nadu and West Bengal, the private sector industry has been largely steering the industrial R&D effort of these states.

(v) R&D Effort of the Small Scale Industry in the Selected States:

Small scale industry has a significant place in the Indian economy, but has largely failed to fulfill its due role mainly because of its anachronistic technological standards, among many other factors. This is also borne out in table 5 that even during the 1990s, when the competitive forces are unleashing due to free market competition and open globalization, the SSI sector has done pretty little to upscale its technological parameters by augmenting its R&D effort, such that during 1990-99, the R&D expenditure of the SSI sector in India increased barely from Rs.36 crore to Rs.98 crore. Out of this, the SSIs in Maharashtra alone accounted for 38-50 percent, where its R&D expenditure increased from Rs.16.75 crore to Rs.40 crore during 1990-99. Karnataka SSIs also have been spending between 10-20 percent of the national SSI R&D expenditure, where it increased from Rs.3.7 crore to Rs.17.66 crore. Andhra Pradesh also spent between 10-12 percent of the national SSI R&D expenditure. However in the case of Tamil Nadu and West Bengal, the proportion of R&D spending on the SSI sector has declined during the 1990s.

(vi) R&D Intensity of the Industrial Sector in the Selected States:

Table 6 projects that the R&D intensity of the industries in Karnataka has been the highest among the selected states, though it declined from 8.5 percent to 6.16 percent during 1990-99, even when the growth of industrial R&D in the state has lagged behind others, as depicted in table 4 above. Similarly, in the case of the most industrially advanced state of Maharashtra, the R&D intensity of industries has gradually increased from about 3 percent to over 4 percent during this period. The steep decline of industrial R&D intensity in Andhra Pradesh, from 6.5 percent to 2 percent is alarming. The decline may be due to the plummeting public sector R&D in the state as highlighted in table 4 above.

Policy Implications and Conclusions:

In the contemporary phase of globalization, where regional specialization would alone reinforce the country's comparative advantage in global markets, industrial development of the regions needs to be brought on a strong footing. Various states/regions specializing in certain type of industries have to upscale their technological standards in order to improve their comparative and competitive advantage. That can be achieved through apportioning larger chunk of the country's R&D expenditure to the state sector. The above analysis bears out a woeful technological research scenario, as less than 10 percent of the national R&D expenditure is allocated to the state sector, which has to be perceivably augmented.

Though in the current phase of privatization, the public sector is euphemistically waning out from the mainstream economic activity, yet as far as R&D is concerned, the public R&D effort should not dwindle in our industrial states, as has been shown in the above analysis. Already under the WTO norms, R&D subsidies have been prohibited or phasing out, so to scaffold our industrial R&D, public sector industries must continue to commit larger resources for technological research. Similarly public agencies must induce the SSIs to exalt their R&D expenditure by providing incentives, both fiscal and monetary sops. Only then the SSI industries would be able to extricate themselves out of the current stagnation and retrogression by becoming competitive. It is, as a matter of fact, now indispensable for industries to enlarge their R&D effort in a liberalized and a globalised milieu, so as to be able to survive and victoriously emerge from the competitive onslaught of the western MNCs, as has been amply demonstrated by the R&D policies envisaged by the telecommunication and pharmaceutical sectors in India (Saha, 2004; and, Lanjouw and Macleod, 2005). So the industries would have to exacerbate their R&D intensities by committing larger proportions from their sale turnover to research and development, which our analysis shows either declining or stagnating.

Table 1

Expenditure on Research and Development in the State Sector (Rs.Crore)

Year	National Aggregate R&D Expenditure	R&D Expenditure in the State Sector
1990-91	3974.17	365.92 (9.21)
1991-92	4512.81	408.58 (9.05)
1992-93	5004.60	503.51 (10.06)
1993-94	6073.02	561.50 (9.25)
1994-95	6622.44	593.06 (8.96)
1995-96	7483.88	657.02 (8.78)
1996-97	8913.61	855.07 (9.59)
1997-98	10611.34	926.76 (8.73)
1998-99	12901.54	1026.54 (9.96)
1999-00	15090.22	1177.46 (7.80)
2000-01	17660.21	1350.56 (7.65)
Annual Growth Rate	15.04	12.97

Note: Figures in the parentheses are % of total

Source: Government of India (Various Issues), *Research and Development Statistics*, New Delhi: Ministry of Science and Technology; Department of Science and Technology.

Table 2						
Expenditure on Research and Development in the Selected States (Rs.Crore)						
State/Year	**1990-91**	**1994-95**	**1996-97**	**1997-98**	**1998-99**	**Annual Compound Growth Rate**
Andhra Pradesh	33.86 (9.25)	58.64 (9.89)	68.58 (8.02)	71.77 (7.74)	81.37 (7.93)	10.23
Gujarat	43.66 (11.93)	20.60 (3.47)	106.19 (12.42)	118.04 (12.74)	147.33 (14.35)	14.47
Karnataka	18.00 (4.92)	48.04 (8.10)	56.21 (6.57)	59.32 (6.40)	63.33 (6.17)	15.00
Maharashtra	53.75 (14.69)	82.21 (13.86)	115.07 (13.46)	120.60 (13.01)	129.17 (12.58)	10.23
Tamil Nadu	28.92 (7.90)	49.35 (8.32)	63.04 (7.37)	70.76 (7.64)	20.72 (2.02)	-3.64
Uttar Pradesh	49.30 (13.47)	76.28 (12.86)	87.43 (10.23)	92.75 (10.01)	97.73 (9.52)	7.90
West Bengal	7.27 (1.99)	20.06 (3.38)	21.47 (2.51)	22.70 (2.45)	25.12 (2.45)	14.77
Aggregate R&D Expenditure in the State Sector	365.92 (100)	593.06 (100)	855.07 (100)	926.77 (100)	1026.76 (100)	12.15
Note: Figures in the parentheses are % of total **Source**: Same as Table 1.						

Table 3							
Applications for Patents Filed From the Selected States (Number)							
State/Year	**1990-91**	**1993-94**	**1994-95**	**1995-96**	**1996-97**	**1997-98**	**1998-99**
Andhra Pradesh	35 (2.97)	22 (1.74)	69 (3.96)	53 (3.30)	75 (4.52)	109 (5.66)	130 (5.79)
Gujarat	44 (3.73)	61 (4.82)	77 (4.42)	75 (4.67)	74 (4.46)	52 (2.70)	58 (2.58)
Karnataka	69 (5.85)	61 (4.82)	82 (4.71)	57 (3.55)	88 (5.30)	105 (5.45)	125 (5.56)
Maharashtra	283 (23.98)	382 (30.17)	526 (30.21)	381 (23.72)	413 (24.87)	580 (30.11)	695 (30.93)
Tamil Nadu	109 (9.24)	104 (8.22)	149 (8.56)	125 (7.78)	173 (10.42)	160 (8.31)	148 (6.59)
Uttar Pradesh	39 (3.31	39 (3.08)	49 (2.81)	35 (2.18)	33 (1.99)	43 (2.23)	55 (2.45)
West Bengal	96 (8.14)	89 (7.03)	152 (8.73)	192 (11.96)	142 (8.55)	140 (7.27)	196 (8.72)
Total for all States	1180 (100)	1266 (100)	1741 (100)	1606 (100)	1661 (100)	1926 (100)	2247 (100)
Note: Figures in the parentheses are % of total **Source**: Same as Table 1.							

Table 4

Industrial R&D Expenditure in the Public and Private Sectors in the Selected States

Year/State	1990-91			1994-95			1996-97			1997-98			1998-99			
	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public
Andhra Pradesh	76.59 (82.73)	15.98 (17.27)	92.57 (100)	104.22 (61.31)	65.78 (38.69)	170.00 (100)	85.47 (54.09)	72.54 (45.91)	158.01 (100)	62.10 (43.49)	80.70 (56.51)	142.80 (100)	63.77 (43.16)			
Gujarat	14.96 (38.65)	23.75 (61.35)	38.71 (100)	16.74 (20.14)	66.39 (79.86)	83.13 (100)	22.97 (16.09)	119.80 (83.91)	142.77 (100)	23.76 (16.47)	120.52 (83.53)	144.28 (100)	27.19 (13.06)			
Karnataka	144.33 (81.52)	32.73 (18.48)	177.06 (100)	261.08 (74.86)	87.66 (25.14)	348.74 (100)	133.49 (56.41)	103.16 (43.59)	236.65 (100)	191.39 (57.20)	143.22 (42.80)	334.61 (100)	234.32 (62.35)			
Maharashtra	18.20 (6.19)	245.02 (93.09)	263.22 (100)	36.38 (6.72)	505.22 (93.28)	541.60 (100)	29.44 (2.62)	1093.00 (97.38)	1122.44 (100)	33.14 (3.15)	1017.66 (96.85)	1050.80 (100)	34.94 (2.92)			
Tamil Nadu	10.18 (13.47)	65.39 (86.53)	75.57 (100)	15.89 (13.56)	101.32 (86.44)	117.21 (100)	16.41 (8.70)	172.15 (91.30)	188.56 (100)	16.90 (8.86)	173.93 (91.14)	190.83 (100)	17.37 (8.48)			
Uttar Pradesh	47.06 (75.09)	15.55 (24.91)	62.61 (100)	77.26 (79.40)	20.04 (20.60)	97.30 (100)	66.87 (63.29)	38.78 (36.71)	105.65 (100)	69.11 (40.98)	99.54 (59.02)	168.65 (100)	81.12 (64.69)			
West Bengal	6.50 (16.95)	31.86 (83.05)	38.36 (100)	5.36 (10.00)	48.25 (90.00)	53.61 (100)	3.73 (6.83)	50.85 (93.17)	54.58 (100)	3.99 (7.48)	49.37 (92.52)	53.36 (100)	4.41 (8.04)			

Note: Figures in the parentheses are % of total

Source: Government of India (Various Issues), *Research and Development in Industry*, New Delhi: Ministry of Science and Technology; Department of Science and Technology.

Table 5					
R&D Expenditure in the Small Scale Industry in the Selected States (Rs.Crore)					
State/Year	**1990-91**	**1994-95**	**1996-97**	**1997-98**	**1998-99**
Andhra Pradesh	3.91(10.80)	8.46(10.85)	10.25(13.55)	12.17(14.27)	12.06(12.29)
Gujarat	1.69(4.67)	6.12(7.85)	5.11(6.75)	3.87(4.54)	6.58(6.71)
Karnataka	3.71(10.24)	11.45(14.68)	14.74(19.48)	17.20(20.17)	17.66(18.00)
Maharashtra	16.75(46.25)	39.31(50.41)	28.80(38.07)	34.17(40.06)	40.03(40.79)
Tamil Nadu	3.11(8.59)	2.60(3.33)	5.01(6.62)	4.78(5.60)	7.45(7.59)
Uttar Pradesh	0.52(1.44)	1.29(1.65)	2.50(3.30)	3.20(3.75)	4.22(4.30
West Bengal	1.34(3.70)	1.24(1.59)	0.88(1.16)	0.90(1.06)	1.00(1.02)
Total R&D Expenditure in all the States	36.22(100)	77.98(100)	75.66(100)	85.29(100)	98.13(100)
Note: Figures in the parentheses are % of total **Source**: Same as table 4.					

Table 6			
R&D Intensity of Industries in the Selected States (Percent)			
State/Year	**1990-91**	**1994-95**	**1997-98**
Andhra Pradesh	6.54	3.42	1.97
Gujarat	1.32	0.86	2.27
Karnataka	8.55	7.50	6.16
Maharashtra	2.98	2.97	4.33
Tamil Nadu	1.68	1.29	2.15
Uttar Pradesh	2.31	1.33	1.84
West Bengal	1.67	1.44	0.72
Note: R&D intensity represents the R&D expenditure as % of net income **Source**: (i) Government of India (Various Issues), *Research and Development In Industry*, New Delhi: Ministry of Science and Technology; Department of Science and Technology. (ii) EPW Research Foundation (2002), *ASI 1973-74 to 1997-98: A Data Base on the Industrial Sector in India*, Mumbai: EPW Research Foundation.			

Notes

1. Whereas the per capita income at constant prices (1993-94) was Rs.14279 in Punjab in 1999, as compared to Rs.13941 in Maharashtra and Rs.13493 in Gujarat, in 2003, real per capita income in Punjab lagged to Rs.16920 in comparison to Rs.17461 in Maharashtra and Rs.17094 in Gujarat. Besides this, in 2003, Punjab contributed barely 3.8 percent to the national GDP, as compared with 8.1 percent by Gujarat and 15.9 percent by Maharashtra and 10.1 percent by Uttar Pradesh (Government of Punjab, 2002; and Saran, 2005).

2. The selected states can be designated as industrially advanced states of India as they have favourable industrial attributes projecting their prime place in these state economies as compared with other states. Though agriculturally advanced states like Punjab and Haryana could have transgressed into the stage of a developed secondary sector, but perhaps the evolutionary process of an economy's development has remained stunted here. For instance, Andhra Pradesh possesses over 10 percent of the country's total registered factories, over 6.75 percent of the country's total fixed capital in industrial sector, and contributes 5.88 percent of the net value added by the country's industries. Similarly, Gujarat accounts for over 11 percent of the country's industrial factories; 16.57 percent of the total industrial fixed capital, and contributes 12 percent of the net value added in the country's industrial sector. Likewise Maharashtra accounts for 14.5 percent of the country's registered factories; 17.5 percent of the country's fixed industrial capital, and contributes over 22 percent of the country's net value added by industry. On the other hand, the prosperous state of Punjab has only 5 percent of the country's factories in the registered sector; has only 2.5 percent of the country's fixed industrial capital, and just contributes 3.6 percent of the industry's net value added in the country (Government of Punjab, 2002).

References

Chadha, V. (1998), "Disparate Regional Technical Development in India: An Inter-State Analysis", *IEA 2nd Amrit Jubilee (81st) Conference Volume*, Bangalore: Indian Economic Association, pp.514-27.

Government of Punjab (2002), *Statistical Abstracts of Punjab*, Chandigarh: Economic Advisor to the Government of Punjab, pp.420-23.

Hoover, E.M. (1975), *An Introduction to Regional Economics*, New York: Alfred A. Knopf, pp.151-67.

Lanjouw, J.O. and M. Macleod (2005), "Pharmaceutical R&D for Low-Income Countries: Global Trends and Participation by Indian Firms", *Economic and Political Weekly*, Vol.XL, No.39, pp.4232-42.

Richardson, H.W. (1996), *Elements of Regional Economics*, Penguin, Harmondsworth.

Saha, B. (2004), "State Support for Industrial R&D in Developing Economies: Telecom Equipment Industry in India and China", Economic and Political Weekly, Vol. XXXIX, No. 35, pp.3515-25.

Saran, R. (2005), "Economic Freedom of States", *India Today*, 15 August, pp.52-57.